PROJECT MANAGEMENT AT HOUSTON

Working Paper No. 16

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[redacted] The research for this paper was supported by National Aeronautics and Space Administration grant NGL 33-022-090 to Syracuse University.

August, 1969

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ABSTRACT

This paper derived from a presentation on the same subject to the SU Project Manager Research Team. It is an attempt to trace out how project management is handled at MSC and to compare this to what was known about MSFC at that time. The paper discusses where and how technical decisions and trade-offs are made, the relations between the Program Manager and the "hardware managers", change control procedure, System Engineering and Project Engineering, sub-systems managers and the relationships between the ASPO and the Directorate for Engineering and Development, and hardware development projects outside of ASPO. The conclusions are related to relations between the ASPO and MSC, the dual nature of MSC as a development and operational field center, the Program and Project orientations and the personalized character of the total Apollo organization.

Project Management at Houston

The organization of the Apollo Spacecraft Program Office (ASPO) at the Manned Spacecraft Center, Houston, Texas is quite different from the organization of the Saturn V Program Office at the Marshall Space Flight Center, Huntsville, Alabama. Yet, these offices are part of the same organization, the National Aeronautics and Space Administration. They have the same responsibility, that of managing contracts for hardware research and development. Their hardware, though different, are integral and integrated parts of a single program, the Apollo Program. With all the similarities of their position, there would seem to be some similarities in the work they do.

This paper attempts to point out some similarities and to explain how the organizational differences influence some working patterns. As it is written, the paper assumes familiarity with the structure and functions of the Saturn V Program Office as well as ASPO. The description of ASPO is based on information obtained through personal interviews with ASPO personnel, other NASA employees and other informants, and is divided into six parts.

1) Technical Decisions and Tradeoffs;
2) The Relations between the Program and the "Hardware" Managers;
3) Change Control Procedures;
4) Systems Engineering and Project Engineering;
5) The Relations Between ASPO and Engineering and Development;
6) Projects Outside of ASPO.

The conclusions presented are very tentative. The analysis of the data was not completed prior to the preparation of this work

and further analysis may greatly modify some of the descriptive material as well as the conclusions. However, the substance of the paper has been subjected to intense discussion on the part of the interdisciplinary research group which is examining project management in the Apollo Program, and the ideas advanced seem adequate, if only tentative. The conclusions are arranged under four headings:

1) Program Office - Center Relations;

2) A Program Center - Developmental and Operating;

3) Program versus Project Organization;

4) A Personalized Organization.

1) Technical Decisions and Tradeoffs

To understand how an organization works, it seems necessary to know where and how the central decisions are made in the organization. To understand project management it seems necessary to understand where and how the tradeoffs between performance, schedule and cost are made for the project. On the basis of the interviews it seems they are made at Houston by the Apollo Configuration Control Board, chaired by the ASPO Manager. Please note well that this reference is to Apollo CCB. That may not be its official designation. It does not seem that any of the interviewees called it that, but that is how it will be regarded, and that bears directly on some of the conclusions. The ASPO Manager is the chairman of the CCB and the Manager for CSM and the Manager for LM are members. The other members are the Directors of the five functional Directorates, and they usually attend in person.

That is the where of decisions. In understanding the how it is important to remember that the Chairman of a CCB in Apollo has full authority. This is not a question of democracy in the sense of voting rights and one man one vote. If there are all Nays except the Chairman's Aye, the Ayes have it. This is not to suggest that this is the practice, but that it is theoretically possible. It would seem that the practice in this case is a matter of the ASPO Manager agreeing with, or following the lead of, the man in whose area the decision primarily falls. This is neither an autocratic show board, nor a democratic nor even a consensual procedure, though votes are often

taken. It appears to be a forum in which everyone has his say and the man who is or appears most knowledgeable has the greatest weight. Indeed, one man even suggested that at times it is almost like a court in which the lawyer who can present his case best will most often win, whether he is right or not. While that is a bit extreme, it does suggest that this is a decision making process or structure with wide latitude to give varying weight to positions that are supported with varying degrees of certainty and conviction, not to say passion. It would also appear that the structure leaves little room for horse-trading or bartering. It is important to note that the membership of the CCB was changed to its present composition. The possible reasons, implications and effects of that change deserve to be discussed in the conclusion.

2) <u>The Relations Between The Program And The Hardware Managers</u>

The reference here is, of course, the ASPO Manager and the Manager for the CSM and the Manager for LM. The latter two are called hardware managers in an attempt to avoid calling them project managers. This is not to assert that they are not project managers, but rather to leave that question open pending the discussion of some further pertinent information.

The first point is that the hardware managers are a part of the ASPO office, indeed they are a part of the Manager's office. They have no personnel under them in an <u>administrative</u> sense, other than their own secretaries. It appears that they have whatever authority that the ASPO Manager cares to give them, and that delegation appears not to be

formally defined except as it is done so by the designation of a particular vehicle system for each of them. It seems that the ASPO Manager uses this delegation authority to shape his organization to fit his personality and capabilities.

Several personnel mentioned his long hours over a six-day work week. In addition it was asserted that he has a fantastic capability to remember and recall great quantities of detailed information. It would seem that the ASPO Manager reserves to himself the major decisions required in the management of the development, fabrication and operation of the Apollo Spacecraft. In this he uses the Managers for CSM and LM as his personal agents or extension of his own personality. They are the ones who go out and actively seek the information, track the activities, make routine decisions, and assure that all the information necessary is available for the ASPO Manager to make the major decisions. They are also the ones who implement and follow-up on the decisions about the development and fabrication of the spacecraft.

What this seems to suggest, though there is relatively little information to back it up, is that the hardware managers have somewhat less authority than a Marshall stage manager and substantially more influence than a "birdwatcher" for Saturn V. The implications of this, again, will be deferred for the conclusions.

3) Change Control Procedures Or How An ECP Is Processed

The processing of change proposals is rather complex and intricate. There are many details involved and there is not space to go into all of them. This section illustrates some working relationships by fol-

lowing a proposal through to the CCB, assuming that it does, for one reason or another, have to go all the way through to get a final decision.

First a change is proposed, usually by a subsystem manager or a contractor. The contractor is asked to comment on it and give a rough order of magnitude estimates as to cost and schedule impact or includes this if it is a contractor proposal. If necessary a detailed technical evaluation is done by the relevant subsystem manager. All change proposals to CSM and LM go through the relevant Contract Engineering Office in Apollo Program Control. This office works up a full cost and schedule evaluation and is responsible for assuring that all the information required to make a decision is assembled in one package. In addition, Contract Engineering examines the proposal to establish that this problem or proposal has not been previously taken care of in some technical direction to the contractor. And they will prepare the terminology for the contracting officer, if necessary.

The chief of the Contract Engineering Branch is the Project Officer for that project and signs off on all technical direction to the contractor. However, they do not make technical decisions; the technical evaluations of change proposals are done by the appropriate branch of Systems Engineering. The Project Officer authority appears to be simply a control point in as much as there are some four persons whose signatures constitute authority for a contractor to act or that the contractor will recognize.

The final step in preparation for the CCB is a meeting of

representatives of the contracting officer, the Contract Engineering Branch and the appropriate Systems Engineering Branch. These people ascertain that the package is complete and try to arrive at a recommended position for the Manager for CSM or LM as the case may be. The actual presentation to the CCB is usually made by the relevant subsystem manager or the contractor.

The Contract Engineering-Program Control arrangement is an interesting and somewhat ambiguous one. The Director for Program Control and Contracts, a Center staff office, is also the ASPO Manager for Contracts and Resources. The Apollo Program Control Chief relates to the ASPO Manager for Contracts and Resources as his superior and the two Contract Engineering Branches are part of the Apollo Program Control operation. Which of his two hats the ASPO Manager for Contracts and Resources is wearing when he directs the Manager of Apollo Program Control and the Contract Engineering Branches is unclear and perhaps immaterial. While it isn't important, it seems that the Contract Engineering operation is administratively a part of the Center staff office of Program Control and Contracts.

4) <u>The Relations Between Systems Engineering And Project Engineering</u>

The previous discussion may have stimulated some questions about the relations between Systems Engineering and Project Engineering. A glance at the chart does nothing to relieve the confusion and a detailed examination brings to light the curious fact that the head of the CSM Engineering which is a branch of Systems Engineering, also heads the System Engineering Office. In addition, the same person is

chief of CSM Project Engineering. One may well conclude that there is little confusion as to who is doing what in the CSM Engineering area. But how is LM Engineering work divided? While it may not be easy, the answer is simple enough. The Project Engineering groups are the home of the vehicle managers. These interesting gentlemen are sometimes referred to as low level expediters since they are concerned with one particular vehicle, CSM 7, CSM 8, LM3, LM5 etc. The branches of Systems Engineering concern themselves with any work that has to be done on all of the vehicles of the series they handle such as the flammable materials rework on CSM and LM. Apparently, Systems Engineering also provides a home for such technical disciplinary specialists as ASPO still retains. To some extent this arrangement exists because each vehicle has a specialized, almost unique, mission. It will have differing components depending on its mission and someone has to track that vehicle from this aspect.

5) Subsystems Managers And The Relations Between ASPO And E&D

The subsystems managers at Houston are located in the functional directorates. Specifically, most of them are located in Engineering and Development. This is one of the biggest contrasts with the Marshall "model," but upon examination it does not appear to be all that great a difference. Originally, or at least earlier, the subsystem managers were in the Program Office, though this was never the case in Apollo. They were located in the Gemini Program Office during the Gemini Program. There seems to be a general consensus that the change was made in an effort to secure more program support from the functional directorates.

While most people felt it was a good move, at least one man felt the problem was solved, or was being solved, before this solution was adopted.

The general consensus held that the subsystems people were quite responsive to ASPO. Indeed, the thought was they are so responsive that they are sort of isolated from the rest of the functional directorates. That the move nevertheless, can be regarded as successful is an interesting point which will be further elaborated in the concluding sections.

In general the E&D Directorate seems to follow the Marshall pattern in having project support offices at the division level to handle the relation to ASPO. The Program people seem to be well aware of who in E&D has individual responsibility for that piece of hardware. This may be partly due to ASPO delegations of responsibility.

6) Projects Outside Of ASPO

This section is somewhat less important or central than the preceding ones, but it is something that ought to be mentioned. There are a number of pieces of Apollo hardware which are being managed as projects by people in the functional directorates. Almost all of these are in E&D. Some of them were always outside ASPO. In some cases ASPO delegated project management authority to the particular division. In most cases, changes above the magnitude cutoff point must be approved by the Apollo CCB. Some examples would be Space Suits, the Portable Life Support System, the Guidance and Navigation Equipment, and the Automated Checkout Equipment.

CONCLUSIONS

1) Program Office - Center Relations

While it may be unsound to arrive at historical conclusions from non-historical data, history has a great deal to do with the patterns described here. The most important historical fact or conclusion in this connection is that at MSC the Program Office has been traditionally strong.

However, in reference to that statement, it would be unfair to think of a program office as being of the size or functions of either ASPO at MSC or the I.O. or even Saturn V and Engine Offices at Marshall. Both the Mercury and Gemini Programs were much smaller and much less complex than Apollo. In addition, there was a single prime contractor for those programs and the contractor carried more of the management burden for those programs. As a result those Program Offices could be smaller, could do less, and still could be strong enough to dominate the Center.

With Apollo, this balance has been somewhat redressed, but only somewhat. It seems to have been a conscious attempt to redress the program-functional balance that resulted in the move of subsystems managers to the functional directorates, that resulted in so many projects being "farmed out" to the functional directorates and that resulted in the Manager for Program Control and Contracts becoming a part of ASPO while retaining his Center staff position.

To say that this was an attempt to redress an inbalance is to use rather cold, analytical terms. One interviewee, at least, described

it as an attempt to get the functional people more involved in Apollo so as to get better support. In another formulation it could be called an extension of program commitment throughout the Center. It seems to have achieved its purpose. And further, it seems that the main problem was not an "I'll take my marbles and go home" attitude on the part of functional people. Rather, the attitude was more "We're here to help. Call us when you need any." But the problem is how can I call on you for help if I don't know what you can do or what it is that I need.

2) A Program Center-Developmental And Operating

Despite all this, it seems that MSC is still unbalanced toward the Program side. Indeed, it would seem that MSC is hardly a Manned Space Center, but rather more of an Apollo Program Center. Whether inbalance in this matter is good or bad is not at all the point. We are attempting to understand the situation.

One good way to make MSC more comprehensible is to regard the ASPO Manager as not the ASPO Manager at all. ASPO stands for Apollo Spacecraft Program Office. But it seems to me that he is managing the Apollo Program as far as Houston is responsible for it. This may not appear to be an important distinction to some, but with some reflection on its implications the importance may become more apparent.

For one thing, MSC is more than a hardware development center. It also has crew training, mission operations, mission control and other operational responsibilities. ASPO seems to be the source of Program Direction for these activities. The mission planning is

carried on in ASPO, in Systems Engineering. This is not the result of bureaucratic imperialism or anything of the sort. Rather, it seems to be the result of historical patterns of operation combined with the fact that the spacecraft is so central to the MSC concerns. What the spacecraft can or cannot do, what is or is not in it or on it, all determine what almost everyone at Houston can or cannot do. As long as the ASPO Manager is Chairman of the CCB and must approve all major changes to the hardware, he has a significant impact on all other activities. One should not wonder that it is this way, but indeed how could it be otherwise? It doesn't seem that all the technical expertise in the world could make the functional people significantly stronger than the Program Office at MSC unless these arrangements were changed. And the program office is still dominant even though, due to personalities and an attempt to secure greater cooperation and support, the Program people seem to have adopted a self-effacing position and have delegated responsibility as much as possible. If competing programs ever becomes a problem in Manned Space Flight, it will be most troublesome at MSC.

3) Program versus Project Organization

There remains the problem of the curious neologism "hardware managers". Perhaps the term should not have been created. It is difficult enough understanding NASA jargon without creating more. Yet it may be useful. If the ASPO Manager is managing the Apollo Program at MSC, it would seem logical that among the projects of that program there would be a CSM project and a LM project. Logical it may be, but

such is obviously not the case. The question is, does this paper difference, this difference in organization charts, does it really mean that there is a difference between Huntsville and Houston in this area? While it is not yet possible to come down firmly on either side of that question, there is some evidence that it does.

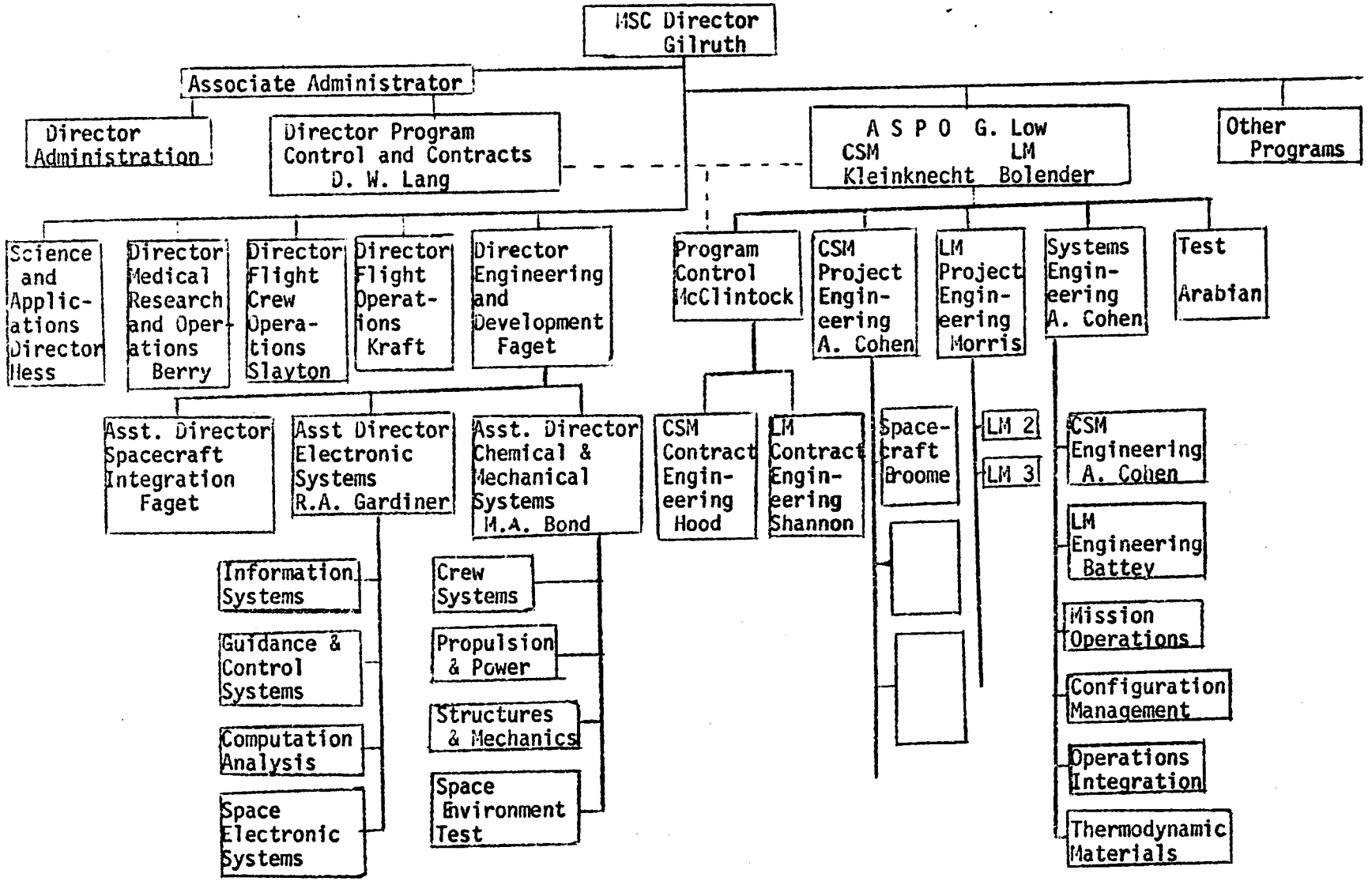
Both the Manager for CSM and LM would prefer to have the subsystems people in the program office. This would make it easier for them, though they are not passionate about it. They have no major complaints. This suggests that the system is working well. It may be that the system is working well because the ASPO Manager, who involves himself very heavily in the day to day management of the CSM & LM is on a level with the Director of E&D, in the organizational structure. If the management authority were delegated down the ladder one rung, if the Managers for CSM and LM were broken off and made project managers, they would be a great deal more concerned and a great deal more definite about where subsystems managers belonged in the organizational set-up.

4) Personalized Organization

A final conclusion applies almost NASA-wide. There seems to be a good deal of evidence pointing to a rather unusual personalized character about the whole NASA Organization. At Houston you hear about Dave and Deke, Chris, Ken, Max, Chip, Owen, Bob, Jim, a good deal of first name references. At Marshall and to an extent at Houston, there seems to be a good deal of reluctance to deal with offices; an insistence on knowing who's responsible, what is his name. Indeed,

the cartoon character who, when confronted by his wife with a letter marked "From the Desk of the President" remarked, "Throw it away. I don't correspond with furniture." must be a NASA employee. There seems to be an odd recurrence of people in key positions that statistical probability would not seem to indicate. The monotonous emphasis in the interviews on human relations skills, on communciation, on face-to-face communication, seems to support this also. And for the exception that proves the rule there is the man who said, "you could be a literal S. O. B. and run a successful program, if you had the technical expertise," and said he had seen it done in NASA.

It is too early to reach any definite conclusions on this point, but it seems like a good point to keep in mind and might well bear further investigation.



Note: Horizontal placement bears no particular significance.

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